Reservoir Monitor Tool Service

THE INDUSTRY'S MOST ACCURATE AND REPEATABLE SLIMHOLE THROUGH-TUBING CARBON/OXYGEN LOGGING SYSTEM

OVERVIEW

The Halliburton Reservoir Monitor Tool (RMT-I™) is a slimhole pulsed-neutron logging system for monitoring and managing the production of hydrocarbon reserves. This unique through-tubing carbon/oxygen (C/O) system has two to three times higher measurement resolution than other systems. Its high-density bismuth germanium oxide (BGO) detectors let the RMT-I tool achieve resolutions previously available only with larger-diameter C/O systems. The RMT-I tool can even be conveyed into a well with tubing completions unlike larger diameter C/O systems that can only log through casing.

INCREASE PRODUCTION, SAVE ON COST

Because the RMT-I tool can accurately evaluate the time-lapse performance of hydrocarbon-producing reservoirs without pulling tubing from the well, it can help operators to:

- Increase production more cost effectively
- Monitor changing conditions and fluid movements
- Tap into bypassed hydrocarbon reserves
- Optimize, manage, and produce reservoirs more efficiently
- Increase production to take advantage of increasing oil prices
- Avoid production problems through enhanced diagnostics
- Make faster decisions on workovers and completions

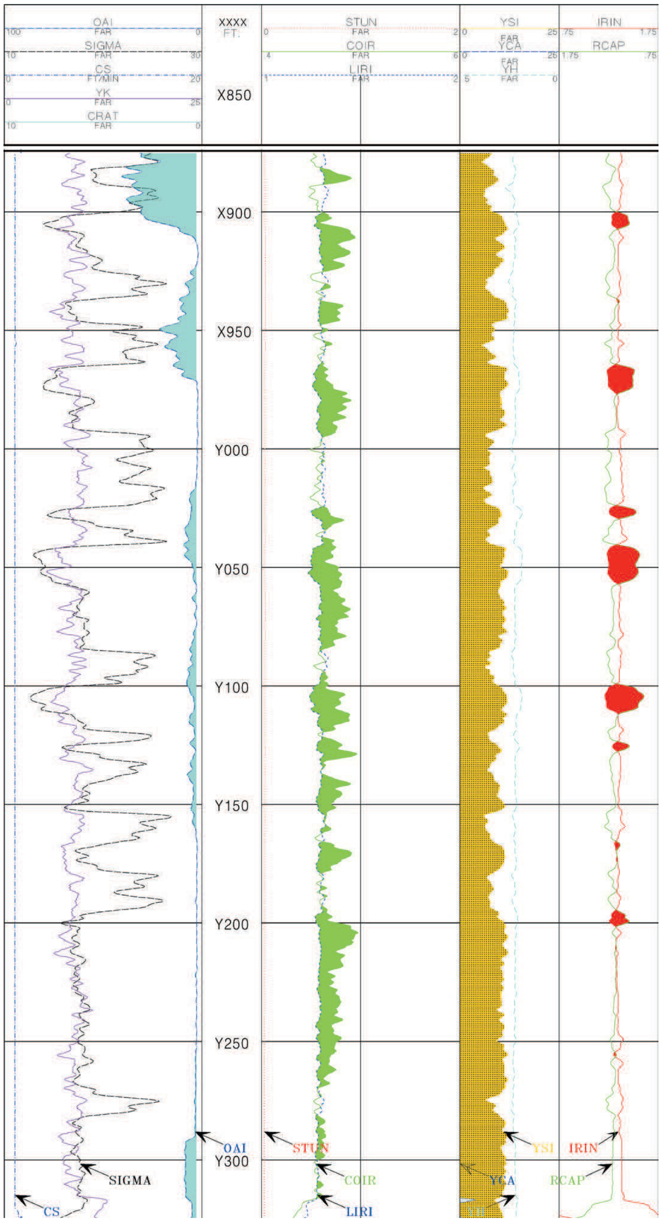
THE RMT-I TOOL CAN ALSO HELP ELIMINATE:

- The cost of killing the well
- The cost of pulling tubing out of the well
- Operational cost and lost production revenue from additional workovers
- Potential production losses due to formation damage from well kill fluids
- The cost of recompleting the well by rerunning tubing

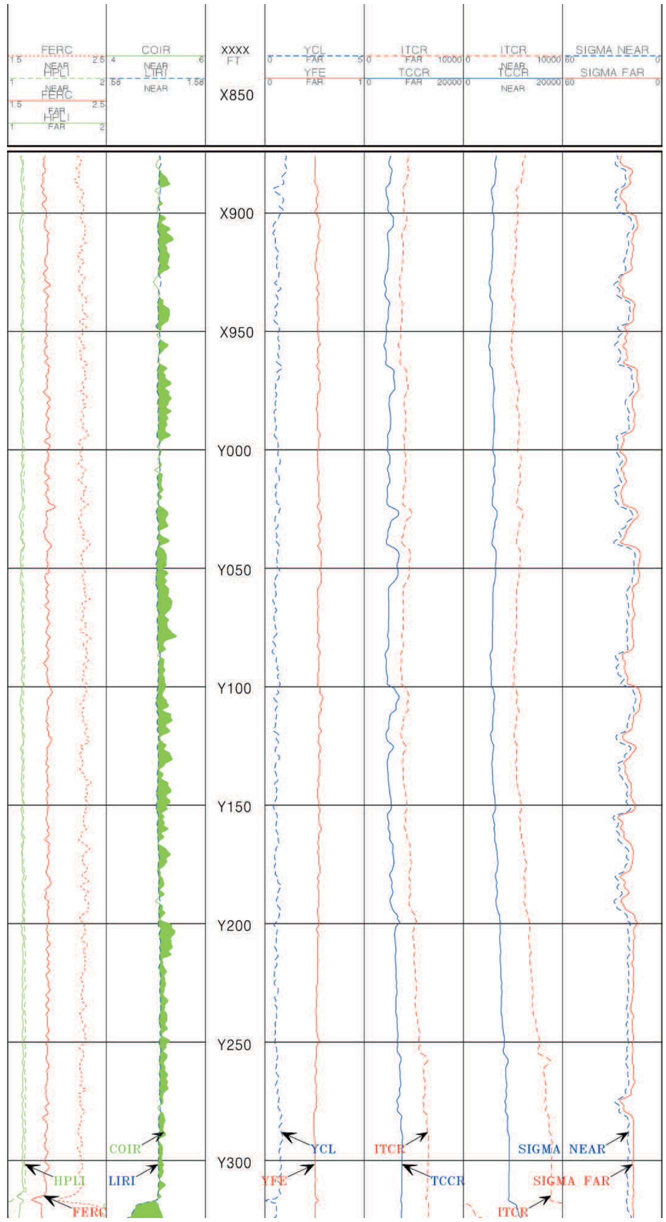
FASTER LOGGING SPEEDS, MORE ACCURATE RESULTS

The Halliburton RMT-I tool can provide accurate and precise results that help operators to achieve logging speeds two to five times faster than any other competing systems. This blazing combination of speed and precision helps enable the RMT-I tool to:

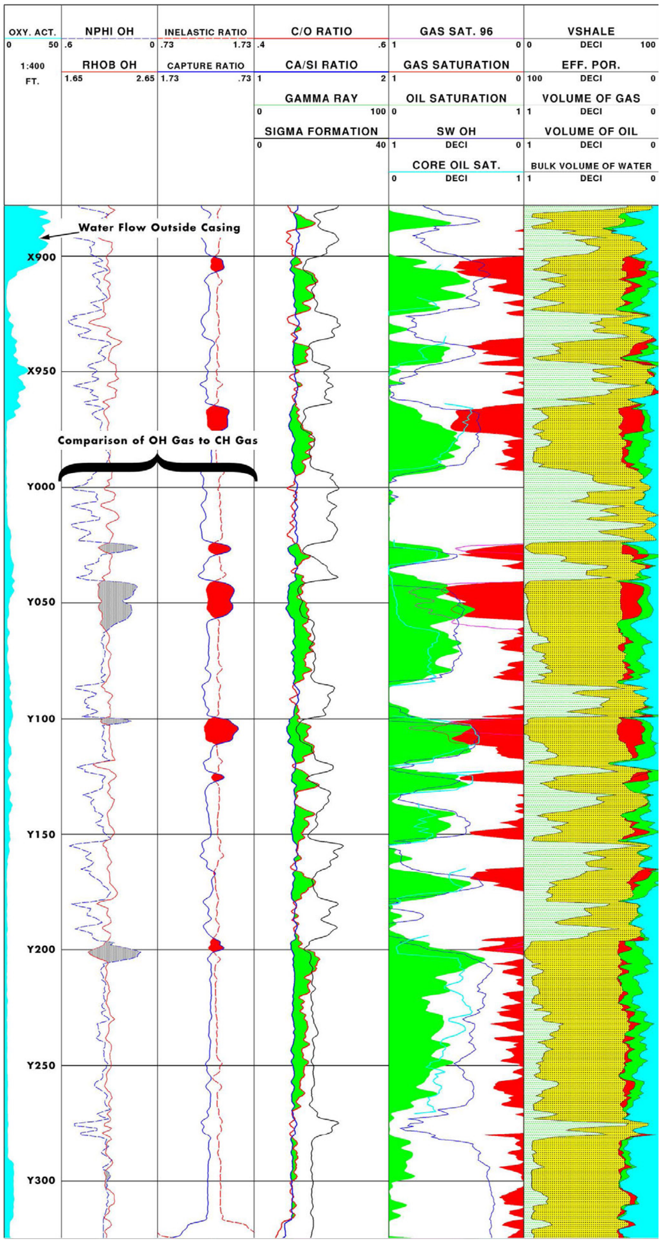
- Accurately determine oil and gas saturations in high-salinity or freshwater formations
- Identify bypassed reserves
- Pinpoint formation fluid contacts
- Identify lithologies and mineralogies
- Provide porosity information within the completion interval
- Evaluate gravel packs and lithology via silicon activation
- Detect water flow inside or outside the pipe



RMT™ Primary Log Presentation – Track 1 of the display is used for plotting basic correlation curves. In this example, the simultaneously recorded formation sigma (SGSM) and the potassium yield curve (YK) are plotted. Also plotted in the track is the oxygen activation curve (OAI), which is used to detect water flow. Track 2 of the log is used to display the raw carbon to oxygen ratio (COIR) and the calcium to silicon ratio (LIRI). The green shading between the curves is a quick-look representation of hydrocarbons. Track 3 of the log displays yield curves computed from the capture spectra for silicon (YSi), calcium (YCa), and hydrogen (YH). Track 4 displays inelastic and capture near-to-far detector ratio curves. These curves are used to identify gas in the formation (shaded in red). Track 5 – Thorium (ppm).



RMT Quality Log Presentation – Track 1 of the presentation are curves that represent the accuracy of spectral gain stabilization measured from ratios of the iron edge (FERC) and the hydrogen peak (HPLI). Track 2 is a plot of the COIR and LIRI from the near-space detector. Track 3 is used to plot additional yield curves computed from the capture spectra. Plotted on this example are the iron yield (YFe) and the chlorine yield (YCl). Tracks 4 and 5 are used to plot the total inelastic and capture count rates for the near and far detectors. Track 6 is used to plot the simultaneous measured near-formation sigma (SGFN) and the far-formation sigma (SGFF).



KernSat Interpretation Example – This well, located in Kern County, California in the Kern River Field, is in an active steam-flood hydrocarbon recovery project. The log displayed to the left is an example of our customized interpretation model KernSat.

Track 4 of the example displays the computed oil saturation (shaded in green) and the gas saturation (shaded in red). These saturations were computed by using a combination of COIR and formation sigma.

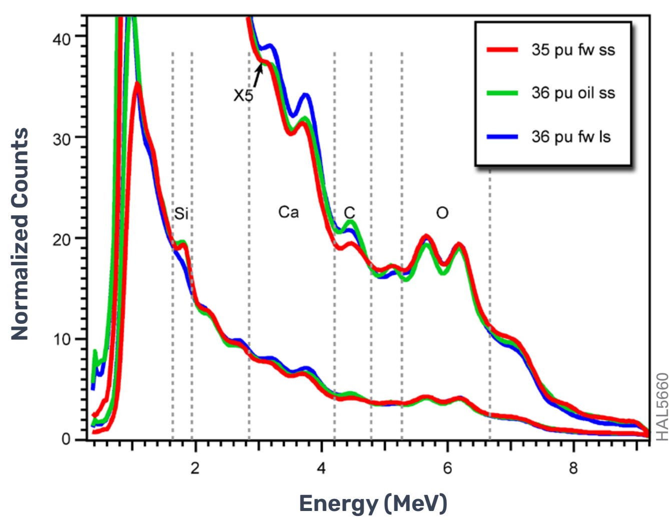
Track 3 displays the COIR and the LIRI curves. The green shading between the two curves indicates hydrocarbons in the formation. Also displayed in the track are the natural gamma ray measurement and the simultaneous recorded formation sigma.

Tracks 1 and 2 display a comparison of the openhole density and neutron porosities and the porosity ratio indicators measured by the RMT™ logging tool. Track 1 is the openhole density-neutron porosity. Steam measured in the formation at the time of the log is indicated by the gray shading between the curves. Track 2 displays the inelastic and capture ratios measured from the RMT logging tool. The red shading indicates the current location of steam in the reservoir. This example indicates that the steam chest has changed when compared to the original formation contacts.

The depth track recorded at the far left side of the log displays water flow measured by the RMT logging tool outside the casing.

ADVANCED MODULAR DESIGN

The Halliburton RMT-I tool modular hardware design provides a highly versatile system that has multiple operating modes and capabilities, enabling operators to make simultaneous C/O, sigma, and water flow measurements. Because the system is modular, it can be combined with a complete string of production-logging tool sensors for detailed production analysis.

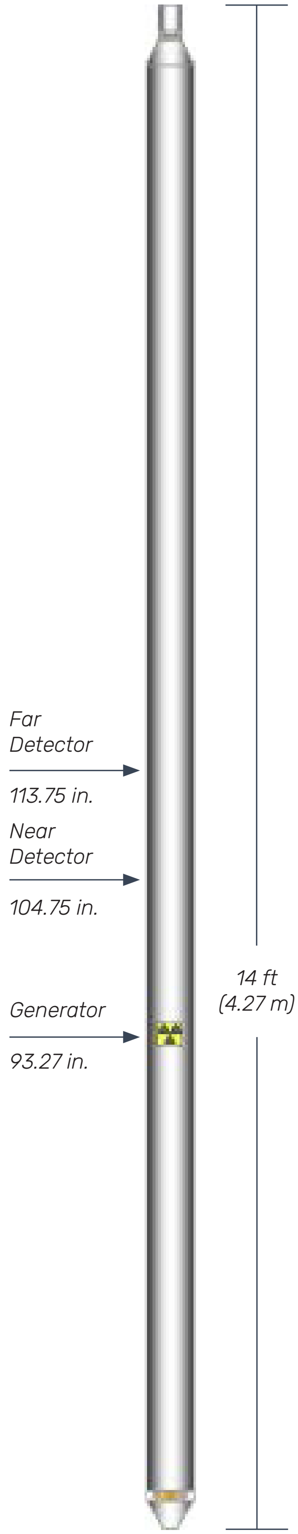


RMT-I Inelastic Spectra – the highest spectral peak resolution of any through-tubing C/O system

Reservoir Monitor Tool 2-Detector Dimensions and Ratings

Dimensions and Ratings	
Maximum Outside Diameter	2.125 in. (5.398 cm)
Maximum Pressure	15,000 psi (103 400 Kpa)
Maximum Temperature	325°F (163˚C)
Minimum Csg/Tbg Inside Diameter	2.375 in. (7.3 cm)
Maximum Csg/Tbg Inside Diameter	16.0 in. (40.6 cm)
Weight	with Gamma Ray and Telemetry 137 lb (62.1 kg)
Length	with Gamma Ray and Telemetry 23.3 ft (7.1 m)
Hardware Characteristics	
Source Type	14-MeV Neutron Generator
Sensor Type	2 BGO Scintillators
Firing Rate (C/O)	One 30 μs burst every 100 μs; One 5 ms background pause burst every 25 ms
Firing Rate (Sigma)	One 80 μs burst every 1250 μs; One 5 ms background pause burst every 25 ms
Sample Rate	4 or 10 samples per ft
Combinability	SBSAT, RCBL, PLT, PAL, CAST-M™* tool
Measurement	
Principle	Neutron-induced Gamma Ray Spectroscopy Induced capture Gamma Die-away
Vertical Resolution	(90%) 30 in.
Depth of Investigation	(50%) 6 in. inelastic; 12 in. capture
Precision (C/O) Ratio	1.5% (1 SD) at 5 ft/min, (C/O) mode
Precision (Ca/Si) Ratio	1.5% (1 SD) at 5 ft/min, (C/O) mode
Precision (SGFF)	2% (1 SD) at 20 ft/min, Sigma mode
Primary Curves (C/O)	C/O ratio, Ca/SI ratio, Near/Far Capture CR, Near/Far Inelastic CR, Inelastic/Capture ratio, Si yield, Ca yield, H yield, Cl yield, K yield, Fe yield, Mg yield
Primary Curves (Sigma)	SGFF, SGBN, Near/Far Capture CR, Near/Far Inelastic CR, Inelastic/Capture ratio, Near CR, Far CR, Inelastic CR
Secondary Curves (C/O)	S yield, Ti yield, H peak ratio, Fe edge ratio, C/O ratio uncertainty, Capture CR, Inelastic CR, O activation CR, SGFF
Secondary Curves (Sigma)	SGFN, SGBF, Decay Curve fit error, O activation CR, Near/Far Amplitude ratio, Near Amplitude
Calibration	
Primary	HES calibration pits, Houston Tool Response and Characterization Laboratory (TRAC Lab)
Secondary	Horizontal water tank
Maximum Logging Speed	5 ft/min (C/O mode), 30 ft/min (sigma mode)

*TBA



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